



## Original Article

## The characterization of trachelectomy for benign and precancerous indications in Taiwan: A population-based study, 1998–2013



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## ABSTRACT

**Objective:** The study aimed to update the utilization trend and characterize the trachelectomy for benign and precancerous indications in Taiwanese women by comparing associated women, surgeon, and hospital-related characteristics.

**Materials and methods:** We conducted a population-based trend study using inpatient admission claims data from Taiwan's National Health Insurance program from 1998 to 2013. After excluding those who had prior subtotal hysterectomy, women who underwent trachelectomy for benign and precancerous indications were compared by age at surgery (younger than 40 years,  $n = 130$ ; 40 and 59 years,  $n = 429$ ; and 60 years or older,  $n = 439$ ). Trend analysis by age groups and indication was performed for the utilization of trachelectomy. A separate descriptive analysis was also performed to evaluate the surgeon's total trachelectomy case volume during the study period.

**Results:** A total of 998 women who underwent trachelectomy for benign and precancerous indications were included in the study cohort. The overall utilization increased considerably by 100% over the study period. The most common indications for trachelectomy were genital prolapse (75.2%) and precancerous cervical lesion (21.0%). The majority of trachelectomies were performed with concomitant colporrhaphy for genital prolapse among older women without comorbid illness or any prior catastrophic illness. Most women (62.9%) were operated by a relatively small number of surgeons with high case volume (12.6%) during the study period. Compared to women older than 40 years, younger women had less comorbidities, more likely to be treated at private medical institution by surgeons of high case volume, and were less likely to undergo concomitant anterior and posterior colporrhaphy.

**Conclusions:** The overall utilization of trachelectomy for benign and precancerous indications has increased over the past 16-years from 1998 to 2013, particularly among older Taiwanese women without comorbid illness or any prior catastrophic illness.

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## Introduction

Over the past years, trachelectomy has been performed for many indications, including prolapse, pelvic mass, and abnormal cervical cytology [1]. Ever since 1990, there has been a consistent increasing trend towards delayed childbearing after age 30 in the United States [2]. As more women are having their first child in their late thirties and early forties, there has been a renewed

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interest in performing trachelectomy when these young women are confronted with severe benign diseases (including extensive lower uterine segment myoma and cervical myoma) that would otherwise require hysterectomy [3–5]. Trachelectomy is considered a fertility-preserving alternative to conventional hysterectomy when these women desire to preserve child-bearing capacity. However, most published studies were case reports and various small retrospective case series [1,6–8], which provided limited information on the trends of the utilization of the procedure. Other studies focused on the neonatal outcome of women with cervical cancer [9–14]. Our current understanding of the common indications came mainly from the largest retrospectively reviewed single-institution case series study conducted more than 10 years ago by Hilger et al. [1] on 310 trachelectomies at a tertiary-care medical clinics between 1974 and 2003. Since there are important differences between utilization trends based on a single-institution experience and a well-defined population, population-based data may more accurately represent the changes in clinical practices and indications over a long period of time in the general female population. Our objectives were to update the utilization trend and characterize the trachelectomy for benign and precancerous indications in Taiwanese women by comparing associated women, surgeon, and hospital-related characteristics.

## Materials and methods

### Study design

We conducted a population-based trend study of all women who underwent trachelectomy for benign and precancerous indications in Taiwan from 1998 through 2013, using the National Health Insurance Research Database (NHIRD). The study was approved by the Institutional Review Board of National Yang-Ming University in Taiwan (No. YM103085E-1).

### Data source

NHIRD is a population-based dataset containing registration files and medical benefit claims filed for reimbursement by all beneficiaries covered under Taiwan's National Health Insurance (NHI) program [15]. The NHI is a single-payer social insurance program for Taiwan's civilian residents with a coverage of 99% in 2010. In this study, analyses were based on the 1997–2013 enrollment data, registry for catastrophic illness, registry for contracted medical facilities, and medical claims for inpatient admissions as previously described [16]. The International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes are available for one primary and up to four secondary diagnoses and procedure per inpatient admission. The dataset was received as de-identified data, and various data files were linked using unique encrypted patient, surgeon, and hospital identifiers across all registries.

### Study population

We retrospectively identified incident cases of trachelectomy from the inpatient admission claims between January 1, 1998 and December 31, 2013 using the ICD-9-CM procedure code for trachelectomy (67.4;  $n = 1554$ ). The index admission was defined as the date of trachelectomy on the inpatient admission claims. Women with the code 54.21 within the same inpatient admission claims of trachelectomy were classified as having had a laparoscopic-assisted trachelectomy. To ensure that all women received trachelectomy only for benign and precancerous diseases, we excluded primary/secondary ICD-9-CM disease codes for

malignant neoplasm of the female genitourinary organs (179–184) ( $n = 262$ ) and primary/secondary ICD-9-CM procedure codes for lymph node dissection (40.3–40.5) within the same inpatient admission claims ( $n = 4$ ). To ensure all women had an intact uterus before undergoing trachelectomy, we also excluded primary/secondary ICD-9-CM procedure codes for total abdominal hysterectomy (68.4), vaginal hysterectomy (68.5), radical abdominal hysterectomy (68.6), radical vaginal hysterectomy (68.7), unspecified hysterectomy (68.9), or subtotal abdominal hysterectomy (68.3), prior or within the same inpatient admission claims ( $n = 145$ ). We further excluded primary diagnoses not relevant to trachelectomy ( $n = 145$ ). In aggregate, a total of 998 women who underwent trachelectomy between 1998 and 2013 were included in the study cohort.

### Covariates

Baseline women (age, residential urbanicity, Charlson comorbidity index, status of any prior catastrophic illness, surgical indication, laparoscopic status, concomitant procedures and index year of trachelectomy), surgeon (age, sex, and total trachelectomy case volume), and hospital characteristics (accreditation level and institution ownership) were defined as the values at the index year. Women's residential urbanicity was classified into urban, suburban, and rural-classification as defined by Liu et al. [17]. Comorbidity was assessed using the Charlson comorbidity index based on at least one inpatient claims filed within a year to a month prior to inpatient admission for trachelectomy [18,19]. Surgical indications for inpatient trachelectomy admission claims were identified using the following ICD-9-CM disease codes: uterine leiomyoma (218), precancerous cervical lesion (233.1, 233.2, 622.1), genital prolapse (618), and non-inflammatory disorders of cervix (622.6, 622.7, 622.8). Concomitant procedures were identified using the following ICD-9-CM procedure codes: lysis of peritoneal adhesions (54.5), partial oophorectomy (65.2), unilateral oophorectomy (65.3, 65.4), bilateral oophorectomy (65.5, 65.6), anterior and posterior colporrhaphy (70.50), anterior colporrhaphy (70.51), and posterior colporrhaphy (70.52). Total case volume was used as a proxy measure of surgeon's surgical experience in trachelectomy. The total case volume treated by each surgeon during the entire study period was calculated and assigned to each woman who underwent trachelectomy. Low-volume surgeons were defined as those performed only one trachelectomy during the study period of 16 years, middle-volume surgeons performed between two and four trachelectomies, and high-volume surgeons as those performing five or more trachelectomies. All medical institutions were classified according to the Taiwan Joint Commission on Hospital Accreditation (medical center, regional hospital, district hospital, or clinics) [20] and as private or public (government-owned) ownership.

### Statistical analysis

The mean (standard deviations, SD) and frequency (%) were presented with continuous and categorical variable, respectively. The dissimilarities in baseline characteristics based on women's age at trachelectomy were compared using one-way analysis of variance test for continuous variables and Pearson's chi-square test for categorical variables. The national trends in the utilization of trachelectomy, mean age at surgery, indications and surgeon's total trachelectomy case volume were illustrated descriptively. The mean age at trachelectomy was compared between five calendar periods (1998–2000, 2001–2003, 2004–2006, 2007–2009, and 2010–2013). Analyses were conducted using the software package SAS for Windows® (release 9.4) (SAS Institute Inc., Cary, NC). All

reported *p*-values were two-sided tests at the 0.05 level of statistical significance.

## Results

### Baseline characteristics

After excluding those who had prior subtotal hysterectomy, a total of 998 women who underwent trachelectomy for genital prolapse, precancerous cervical lesion, uterine leiomyoma, or non-inflammatory disorders of cervix were identified in Taiwan from 1998 through 2013. The cohort included 130 (13.0%) women younger than 40 years, 429 (43.0%) women aged 40–59 years, and 439 (44.0%) women aged 60 years or older (Table 1). Most trachelectomies were performed with concomitant colporrhaphy for genital prolapse among older women without comorbid illness or any prior catastrophic illness by male surgeons aged between 45 and 54 years with high case volume in medical centers of private ownership (Table 2). Compared to women older than 40 years, younger women had less comorbidities, more likely to be treated at private medical institution by surgeons of high case volume, and

were less likely to undergo concomitant anterior and posterior colporrhaphy ( $P < 0.05$  for all).

### Trend analysis

The overall utilization of trachelectomy doubled from 45 cases in 1998 to 90 in 2013, with the largest increase occurring between 2006 and 2011 (relative increase of 151.2%) (Fig. 1) and in women older than 60 years (144.4% increase from 18 cases in 1998 to 44 cases in 2013). Compared to younger women, women older than 40 years underwent trachelectomy more frequently in the later years after 2006. Fig. 2 compares the annual incidences of trachelectomy by indications. The utilization of trachelectomy for genital prolapse increased by 200% from 1998 to 2013. In contrast to the overall increasing utilization trend, precancerous cervical lesion was associated with decreased performance of trachelectomy. There were little differences in the utilization of trachelectomy for both leiomyoma and non-inflammatory disorders of cervix (mean [range], 1.1–1.3 cases per year [1–3 cases]).

The distribution of trachelectomy for benign and precancerous indications stratified by surgeon's total trachelectomy case

**Table 1**

Baseline women characteristics of trachelectomy for benign and precancerous indications in Taiwanese women, 1998–2013 (N = 998).

Independent variables	All (n = 998; 100%)	Younger than 40 y (n = 130; 13.0%)	40–59 y (n = 429; 43.0%)	60 y or older (n = 439; 44.0%)	<i>P</i>
<b>Women characteristics</b>					
Mean age (SD), y	56.7 (14.3)	35.4 (3.9)	49.0 (5.5)	70.6 (6.9)	<0.001
Residential urbanicity, n (%)					
Urban	301 (30.2)	37 (28.5)	150 (35.0)	114 (26.0)	<0.001
Suburban	567 (56.8)	78 (60.0)	247 (57.6)	242 (55.1)	
Rural	105 (10.5)	7 (5.4)	21 (4.9)	77 (17.5)	
Unknown	25 (2.5)	8 (6.2)	11 (2.6)	6 (1.4)	
Charlson comorbidity index $\geq 1$ , n (%)	32 (3.2)	0	9 (2.1)	23 (5.2)	<0.01
Any prior catastrophic illness, n (%)	40 (4.0)	3 (2.3)	13 (3.0)	24 (5.5)	0.11
Surgical indication, n (%)					
Genital prolapse	750 (75.2)	104 (80.0)	321 (74.8)	325 (74.0)	<0.001
Precancerous cervical lesion	210 (21.0)	18 (13.8)	83 (19.3)	109 (24.8)	
Uterine leiomyoma	20 (2.0)	3 (2.3)	15 (3.5)	2 (0.5)	
Non-inflammatory disorders of cervix	18 (1.8)	5 (3.8)	10 (2.3)	3 (0.7)	
Laparoscopic approach, n (%)	54 (5.4)	8 (6.2)	37 (8.6)	9 (2.1)	<0.001
Oophorectomy, n (%)					
None	951 (95.3)	129 (99.2)	407 (94.9)	415 (94.5)	0.10
Partial	6 (0.6)	0	5 (1.2)	1 (0.2)	
Unilateral	22 (2.2)	0	11 (2.6)	11 (2.5)	
Bilateral	19 (1.9)	1 (0.8)	6 (1.4)	12 (2.7)	
Colporrhaphy, n (%)					
None	416 (41.7)	57 (43.8)	190 (44.3)	169 (38.5)	<0.001
Anterior and posterior	474 (47.5)	51 (39.2)	183 (42.7)	240 (54.7)	
Anterior	33 (3.3)	5 (3.8)	15 (3.5)	13 (3.0)	
Posterior	75 (7.5)	17 (13.1)	41 (9.6)	17 (3.9)	
Lysis of peritoneal adhesions, n (%)	60 (6.0)	3 (2.3)	23 (5.4)	34 (7.7)	0.05
Index year of trachelectomy, n (%)					
1998	45 (4.5)	6 (4.6)	21 (4.9)	18 (4.1)	0.12
1999	53 (5.3)	8 (6.2)	18 (4.2)	27 (6.2)	
2000	46 (4.6)	8 (6.2)	13 (3.0)	25 (5.7)	
2001	58 (5.8)	12 (9.2)	24 (5.6)	22 (5.0)	
2002	45 (4.5)	9 (6.9)	15 (3.5)	21 (4.8)	
2003	46 (4.6)	6 (4.6)	18 (4.2)	22 (5.0)	
2004	48 (4.8)	5 (3.8)	21 (4.9)	22 (5.0)	
2005	53 (5.3)	12 (9.2)	22 (5.1)	19 (4.3)	
2006	41 (4.1)	7 (5.4)	19 (4.4)	15 (3.4)	
2007	57 (5.7)	7 (5.4)	33 (7.7)	17 (3.9)	
2008	54 (5.4)	3 (2.3)	29 (6.8)	22 (5.0)	
2009	76 (7.6)	12 (9.2)	37 (8.6)	27 (6.2)	
2010	89 (8.9)	10 (7.7)	34 (7.9)	45 (10.3)	
2011	103 (10.3)	10 (7.7)	41 (9.6)	52 (11.8)	
2012	94 (9.4)	6 (4.6)	47 (11.0)	41 (9.3)	
2013	90 (9.0)	9 (6.9)	37 (8.6)	44 (10.0)	

Abbreviation: SD, standard deviation.

*P* (*P*-value,  $\chi^2$  test or one-way analysis of variance test).

**Table 2**

Baseline surgeon and hospital characteristics of trachelectomy for benign and precancerous indications in Taiwanese women, 1998–2013 (N = 998).

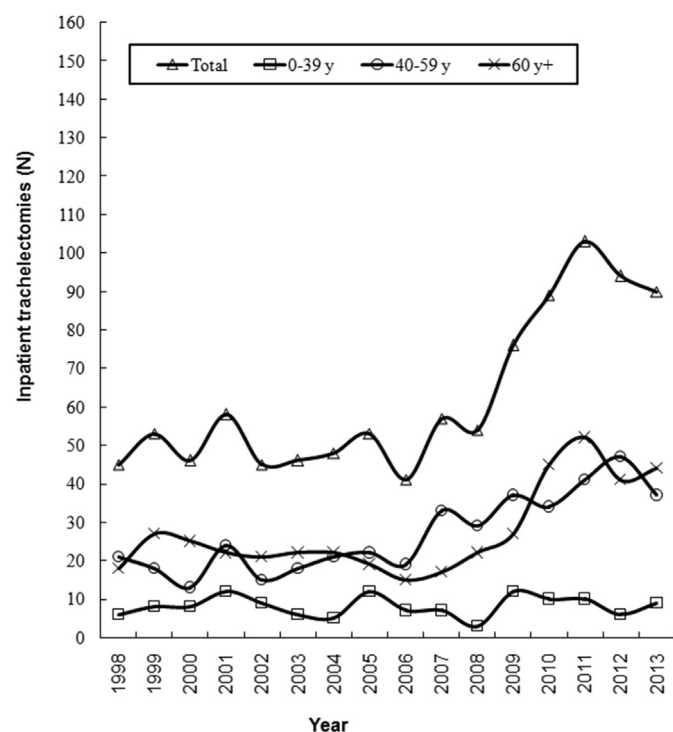
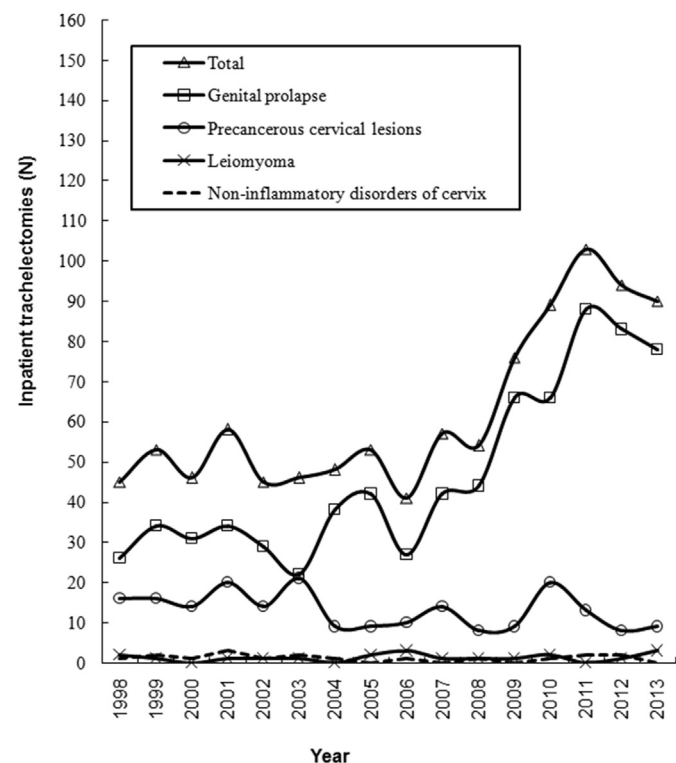
Independent variables	All (n = 998; 100%)	Younger than 40 y (n = 130; 13.0%)	40–59 y (n = 429; 43.0%)	60 y or older (n = 439; 44.0%)	P
<b>Surgeon characteristics</b>					
Mean age (SD), y <sup>†</sup>	48.5 (8.0)	49.3 (7.8)	48.8 (8.0)	47.9 (8.0)	0.13
Age group, n (%)					
<35 y	21 (2.1)	3 (2.3)	8 (1.9)	10 (2.3)	0.09
35–44 y	295 (29.6)	31 (23.8)	112 (26.1)	152 (34.6)	
45–54 y	466 (46.7)	63 (48.5)	212 (49.4)	191 (43.5)	
≥55 y	214 (21.4)	32 (24.6)	97 (22.6)	85 (19.4)	
Unknown	2 (0.2)	1 (0.8)	0	1 (0.2)	
Sex, n (%)					
Female	131 (13.1)	12 (9.2)	57 (13.3)	62 (14.1)	0.07
Male	866 (86.8)	117 (90.0)	372 (86.7)	377 (85.9)	
Unknown	1 (0.1)	1 (0.8)	0	0	
Total trachelectomy case volume, n (%)					
Low (1 procedure)	166 (16.6)	15 (11.5)	60 (14.0)	91 (20.7)	<0.001
Middle (2–4 procedures)	204 (20.4)	15 (11.5)	72 (16.8)	117 (26.7)	
High (≥5 procedures)	628 (62.9)	100 (76.9)	297 (69.2)	231 (52.6)	
<b>Hospital characteristics</b>					
Accreditation level, n (%)					
Clinic	5 (0.5)	2 (1.5)	1 (0.2)	2 (0.5)	0.06
District hospital	74 (7.4)	10 (7.7)	36 (8.4)	28 (6.4)	
Regional hospital	273 (27.4)	24 (18.5)	113 (26.3)	136 (31.0)	
Medical center	646 (64.7)	94 (72.3)	279 (65.0)	273 (62.2)	
Institution ownership, n (%) (private)	785 (78.7)	113 (86.9)	349 (81.4)	323 (73.6)	<0.001

Abbreviation: SD, standard deviation.

P (P-value,  $\chi^2$  test or one-way analysis of variance test).<sup>a</sup> Mean surgeon age was based on 996 women.

volume is shown in Fig. 3. A total of 285 surgeons performed trachelectomies for benign and precancerous indications in Taiwan during the study period. Overall, surgeons performed a mean (SD) of 3.50 (8.14) procedures (median, 1.00; mode, 1.00; range, 1–72) with a right-skewed distribution during this time

frame. More than half of the surgeons (n = 166, 58.2%) were novice surgeons with low case volume and performed 166 (16.6%) trachelectomies throughout the entire 16 years. The other 83 (29.1%) surgeons with middle case volume were responsible for 204 (20.4%) trachelectomies. The remaining 628 (62.9%)

**Fig. 1.** Nationwide trend of trachelectomy for benign and precancerous indications by age group and year (1998–2013) (N = 998).**Fig. 2.** Nationwide trend of trachelectomy by indications and year (1998–2013) (N = 998).

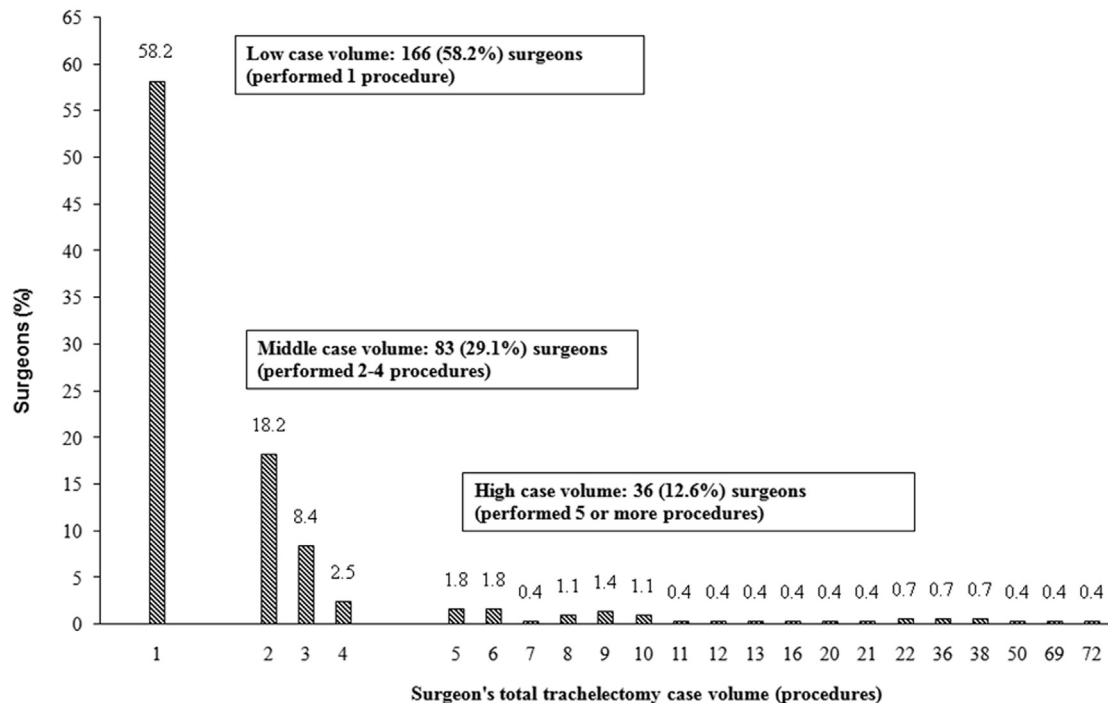


Fig. 3. Distribution of trachelectomy for benign and precancerous indications stratified by surgeon's total trachelectomy case volume (1998–2013) (N = 285).

trachelectomies were performed by 36 (12.6%) surgeons with high case volume.

## Discussion

This population-based study suggests that the utilization of trachelectomy doubled (i.e. by 100%) over the past 16-years from 1998 to 2013 among Taiwanese women. Overall, the majority of trachelectomies were performed with concomitant colporrhaphy for genital prolapse among older women without comorbid illness or any prior catastrophic illness. Most women (62.9%) were operated by a relatively small number of surgeons with high case volume (12.6%) during the study period. Compared to women older than 40 years, younger women had less comorbidities, more likely to be treated at private medical institution by surgeons of high case volume, and were less likely to undergo concomitant anterior and posterior colporrhaphy.

In contrast to the decline trend for all indications as reported by Hilger et al. [1] between 1974 and 2003 at Mayo Clinic's campuses in the United States, these authors reported an 88% relative reduction from 90 to 11 cases of trachelectomy between the periods 1974–1978 and 1999–2003 at Mayo Clinic's campuses (Rochester, Minnesota or Scottsdale, Arizona) in the United States. One explanation for the observed increasing trend could be attributed to the difference in healthcare system. Surgeons under the market-based health insurance system in the United States are expected to practice differently than those under the compulsory social health insurance program in Taiwan. However, the inconsistency between the findings reported by Hilger et al. [1] and our study could also be recognized as the difference between data types (population-level based claim data compared to a single-institution experience). Studies based on population-based data provide a higher level of evidence on a nationwide scale than studies from small sample sizes or single institution experience. The other explanation of the increasing trend could partially reflect the trend of choosing trachelectomy over hysterectomy for genital prolapse. In the United

States, 48,265 fewer hysterectomies were performed for genital prolapse between 2002 and 2010 [21]. Although only 364 fewer hysterectomies were performed for genital prolapse between 1998 and 2010 in Taiwan [22], any numbers of women who chose trachelectomy over hysterectomy would contribute to the observed increasing trend when only 501 women underwent trachelectomies from 1998 to 2010 for genital prolapse in our study. Another explanation of the increasing trend could partially reflect the trend of delayed childbearing in young women. In our study, roughly one-eighth (13.0%) of women aged less than 40 years had trachelectomy. Young women frequently underwent trachelectomy for genital prolapse or precancerous cervical lesions in Taiwan. These women were expected to choose fertility-preserving trachelectomy over conventional hysterectomy for future pregnancy [4]. Nevertheless, the increasing utilization of trachelectomy among women older than 60 years (Fig. 1) and genital prolapse (Fig. 2) opened up another plausible explanation. In this study, the mean age of women at trachelectomy was 56.7 years (Table 1) and the differences varied significantly between the calendar periods ( $P = 0.003$ ) from 56.5 years in 1998–2000 to 59.0 years in 2010–2013 (Fig. 4). Rather than the increasing popularity of the procedure in young women, the rise in aging population in Taiwan is expected to increase the incidence of genital prolapse in older women, which can then lead to the observed increasing utilization of trachelectomy.

The implementation of the nationwide Pap smear screening tests since 1995 might play an important role in the observed decreasing trend in the utilization of trachelectomy for precancerous cervical lesions [23]. The early identification of precancerous cervical lesions allows earlier treatment by less invasive surgery such as transcervical resection of focally growing precancerous lesions. We can anticipate that the improvement in the screening efficacy will bring about an even lower utilization rate of trachelectomy for precancerous cervical lesions in the future.

The effect of surgeon case volume on surgical outcomes has gained growing recognition in recent years for many procedures [24–29]. Due to the rarity of this procedure, no study is currently



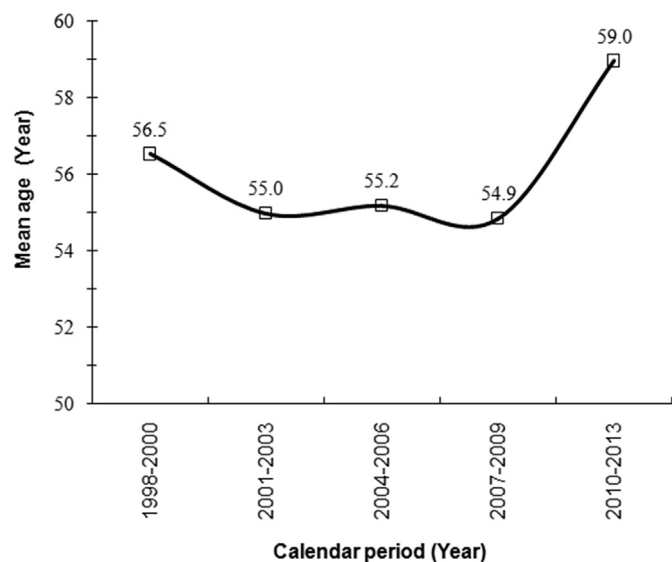


Fig. 4. Nationwide trend of trachelectomy by mean age and calendar periods (1998–2000, 2001–2003, 2004–2006, 2007–2009, and 2010–2013) (N = 998).

available on the effect of surgeon case volume on the surgical outcome of trachelectomy for benign and precancerous indications. In our study, we briefly explore the distribution of surgeon's total case volume during the study period. The calculation of annualized volume estimates of trachelectomy as described by Wright et al. [25,26,29] was not possible because more than half (58.2%) of the 285 surgeons had performed only one procedure during the study period. Most trachelectomies (62.9%) were performed by a relatively small number of experienced surgeons (12.6%) with high case volume. In contrast, the majority of surgeons (76.5%) were under-experienced having performed only one or two trachelectomy. Our findings raise an important question that if most surgeons have minimal experience with trachelectomy, how do we maintain the quality of care among women who undergo trachelectomy for benign and precancerous indications? We suggest that the surgeon who is being credentialed must include satisfactory completion of an accredited surgical residency program to perform trachelectomy or proctored for a minimum of three cases by a certified surgeon.

We recognize several important strengths and limitations in the current study. First, given that the original purpose of NHIRD are for billing, the nationally uniform single-reimbursement coding system allows the enumeration of all cost-related inpatient procedures with minimal bias in Taiwan, including trachelectomy. Second, since all women have similar access to a universal, single-payer health care system in Taiwan, there would be limited selection bias in the observed national trends when compared with case series from countries provided mainly by market-based health insurance system as in the institutional study by Hilger et al. [1]. On the other hand, the current study was limited by the nature of an administrative claim records submitted for insurance reimbursement purposes. First, it lacks clinical variables (pathological reports to confirm the status of surgical indications) and surgeon training variables (years in prior experience or level of training in surgical procedures), which may confound our results. We used surgeon's total trachelectomy case volume as a proxy measure of surgical experience in trachelectomy. Second, since the ICD-9 procedure coding system employed in this dataset did not contain specific codes for abdominal or vaginal approaches, it did not allow the assessment of approach-related trends for trachelectomy. Third, since our dataset began from 1997, we were unable to exclude

women who underwent subtotal hysterectomy prior to that time. However, by limiting our study cohort between 1998 and 2013, each woman had a minimum of one-year observation period prior to index admission.

## Conclusions

Despite limitation, there is an increasing surgical trend of trachelectomy performed for benign and precancerous indications over the past 16-years from 1998 to 2013, particularly among older Taiwanese women without comorbid illness or any prior catastrophic illness. We noted that the utilization of trachelectomy is concentrated in a small numbers of surgeons. If trachelectomy is to become a commonly performed procedure, further studies are required to determine the short-term and long-term influence of surgeon's case volume on in-hospital surgical complications of trachelectomy.

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## Conflict of interest

The authors declare no conflicts of interest.

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